REMARKS

With the above amendments, the specification has been amended to incorporate the International and Japanese priority applications by reference, and to improve punctuation, spelling and grammar. The claims have been amended to place them in better form for examination. The Abstract of the Disclosure and the Drawings have been amended to comply with formal requirements of the United States Patent and Trademark Office (USPTO).

A substitute specification in compliance with 37 C.F.R. §1.125 is attached. The attached substitute specification contains no new matter.

Accordingly, it is believed that the application is in good condition for examination. The below-signed attorney for Applicants welcomes any questions.

Respectfully submitted,

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AMENDMENTS TO THE DRAWINGS:

The attached three (3) sheets of drawings include changes to Figures 17 to 20. These three sheets include Figures 16 to 20. Figures 17 to 20 have been labeled as "Prior Art" in accordance with MPEP § 608.02(g).

Attachments: Three Replacement Sheets

~~SPECIFICATION~~

VACUUM THERMAL INSULATING VAVLE

[0000] This is a National Phase Application in the United States of International Patent Application No. PCT/JP2005/000265 filed January 13, 2005, which claims priority on Japanese Patent Application No. JP 2004-014032, filed January 22, 2004. The entire disclosures of the above patent applications are hereby incorporated by reference.

Field of the Invention

[0001] The present invention is concerned with improvements in a vacuum thermal insulating valve employed in a pipe passage for a gas supply system, or a gas exhaust system, mainly in semiconductor manufacturing facilities or chemical plants.

Background of the Invention

[0002] With a~~the~~ gas supply system with which ~~the~~ liquefied gas is vaporized, it has been conventionally practiced to heat~~that~~ the pipe passage ~~is heated~~ to more than a specified temperature to prevent the supply gas from re-condensing~~ation~~ in the pipe passage. Similarly, ~~also~~ with a~~the~~ gas exhaust system in semiconductor manufacturing facilities, plasma generating apparatuses and the like, the pipe passages, valve devices mounted thereon, and the like, have been heated to prevent ~~the~~ exhaust gas from forming gas condensation in the pipe passage.

[0003] For example, the internal pressure of a process chamber for semiconductor manufacturing facilities can be~~is~~ kept evacuated to approximately 10^{-4} to~~∼~~ 10^{2} torr, depending on the type of the process, by making~~to make~~ the exhaust side of the chamber ~~being~~ continuously exhausted by a vacuum pump._ ————On the other hand, ~~due~~ because~~to the reason that~~ necessary treatments are performed by using various kinds of corrosive gases or toxic gases, a large_-

~~-1-~~

amount of corrosive gases, and the like, are found in the exhaust gases passing through the exhaust system.__ ————Accordingly, for an~~with the~~ exhaust system for the process chamber, condensation of the corrosive gas is prevented by heating pipe passages or valve units;~~,~~ thus, the devices constituting the exhaust system are~~being~~ prevented from corrosion because corrosive effects are substantially increased when~~with~~ corrosive gases liquefy~~liquefied~~ due to condensation.

[0005] Also, with semiconductor manufacturing facilities, it is~~has been~~ strongly desired that the entire unit, including the exhaust system of the process chamber, be~~is~~ further downsized. Therefore, for~~with~~ the vacuum exhaust system of the process chamber, it is also strongly desired to make~~ing~~ small the diameter of the exhaust pipe passage, downsize~~ing of~~ the vacuum exhaust pumps, downsize~~ing~~ ~~of~~ valves to be employed, and the like ar~~e also strongly desired~~, and ideas to realize these desires~~demands~~ have been studied. Particularly, for~~with~~ the vacuum exhaust system, more efforts has been made~~have been put further~~ to further downsize the pipe passages and valves by enhancing their thermal

insulating performance.

[0006] With regard to the pipe passages of the vacuum exhaust system in semiconductor manufacturing facilities and the like, the initial objective has been nearly achieved~~attained~~ by employing a vacuum thermal insulating pipe passage.

However, with regard to a valve unit that~~which~~ constitutes a vacuum exhaust system, there remain many unsolved problems,~~difficulties~~ such as thermal insulating capabilities, downsizing, energy-saving and the like.

[0007] Though the explanation ~~is~~ given here is with regard to ~~the~~ problems ~~-2-~~ related to the vacuum exhaust system for semiconductor manufacturing facilities, it goes without saying~~there is no need to say~~, however, that such~~these~~ problems have some similarities with the problems of~~with~~ the gas supply system on the upstream side, and the gas supply system or gas exhaust system in other chemical apparatuses, and the like. Accordingly, the gas supply system, exhaust system for semiconductor manufacturing facilities, and the like, are used as examples to explain these problems as follows~~difficulties hereunder~~.

[0008] A so-called "unit-type valve" V, constituted as shown in Figure 17 to Figure 20, has been widely used for semiconductor manufacturing facilities and the like to make a valve that is~~itself~~ small and compact. For example, the unit-type valve V shown in Figure 17 and Figure 18 has outer dimensions of 150~500mm in breadth, 130~150mm in height, and 80~100 in depth. In particular

~~Namely~~, the valve V is made of a valve unit body V_1 formed by

combining a plural number of valve bodies V_{10}, V_{20} …., and actuators D mounted on the valve bodies V_{10}, V_{20}…… respectively. The valve itself, as a unit, is a metal diaphragm type valve comprising the valve body V_{10} and the actuator D. The afore-mentioned valve V is heated to normally approximately 150℃ by a heater (not illustrated) to prevent corrosive gases passing through the inside from condensing~~being condensed~~.

[0009] The heated valve V is of a very compact structure, and its temperature is held at less than a~~the~~ temperature (approximately 40℃) that allows it to~~so it can~~ be touched by hands from the outside. And, heated valve V~~it~~ needs thermal insulation so that ~~the~~ leakage of heat directly to the outside is prevented. ~~-3-~~ In the case where rock wool is used as a thermal insulating material, the thickness of the wool needed for one side will be 30 to ~~~~~50mm, thus making it difficult to~~that it is~~ compact-size~~d~~ the valve V.

[0010] Similarly, in the case where the~~a~~ valve V is made to be enclosed by a pneumatic thermal insulation type box body (equipped with a silver-plated layer to suppress heat transfer by radiation on the inner wall surface and made with an~~the~~ air layer of~~to be~~ 10mm) of a double wall structure, it was ~~found~~ difficult to reduce~~that~~ the temperature of the outer surface of the thermal insulating box ~~was reduced~~ to less than approximately 40℃ because of ~~the~~ heat transfer by convection of the air layer.

[0011] Therefore, first, the inventors of the present invention developed a vacuum thermal insulating valve, which was made to house a valve unit body V_1 of the valve inside a~~the~~ vacuum thermal insulating box S, by making use of

vacuum thermal insulation as shown in Figure 21. It was learned, however, that the vacuum thermal insulating valve in Figure 21~~it~~ was not commercially practical because~~with the vacuum thermal insulating valve in Figure21 due to the reason that~~ the temperature of the outer surface (i.e., the surface temperature of the actuator in the center part) became higher than the specified temperature (40℃)~~ by any means~~.

[0012] Therefore, inventors of the present invention formed a vacuum thermal insulating box S made by combining 3 vacuum jackets S_1, S_2, S_3 as shown in Figure 22 to ~~∼~~Figure 25, and conducted various kinds of tests using this~~e~~ box.

In~~With~~ Figure 22 to ~~∼~~Figure 25, the main reasons why the vacuum thermal insulating box S is divided into 3 vacuum jackets S_1, S_2, S_3, or the first, second and third vacuum jackets, are that a vacuum thermal insulating pipe receiving -

-4-

part J can be easily fabricated and also ~~that~~ the ~~distance of the~~ solid heat transfer distance can be made longer this way. In

~~With~~ Figure 22 to ~~∼~~Figure 25, K designates a silicon sponge-made thermal insulating layer (thickness t = 2mm), H a plane heater, G a getter case, J a vacuum thermal insulating pipe receiving part, O a seal-off valve, Q a cable takeout opening, and OUT and IN are temperature measuring points.

Furthermore, in~~with~~ Figure 22 to ~~∼~~Figure 25, a 2mm-thick stainless steel plate is used for the metal plate that~~which~~ constitutes vacuum jackets S_1, S_2, S_3. The entire inner wall faces of the vacuum jackets S_1 to ~~∼~~S_3 are given electroless Ag plating, and then a vacuum heating treatment of 550℃ x 2hrs is

conducted on the~~said~~ silver plating layer to enhance its emissivity.

[0013] With Figure 25, ~~there are shown~~ other temperature measuring points are shown beside temperature measuring points IN and OUT in the afore-shown Figure 22 to ~~~~~Figure 24. Figure 26 and Figure 27 show the results of temperature measurements at each measuring point of the first vacuum jacket S_1 and the second vacuum jacket S_2.

[0014] On the other hand, the thermal insulating performance of 2 vacuum thermal insulating boxes S can be demonstrated~~presented~~ by the electric power required to hold the inside of the vacuum thermal insulating boxes S at the specified temperature used for comparison~~being compared~~.

First, the inventors of the present invention made adjustable the voltage to be applied to a plane heater H (100V・200W・50Ω x 2 pieces), and at the time when the temperature of the valve unit body V_1 reached equilibrium (approx. 3–~~5~~ hours ~~later~~ after the start of heating), power consumption was measured both under conditions~~at the time~~ when the vacuum thermal insulating box S was inserted, and the vacuum thermal insulating box S was not inserted, respectively.

[0015] It was~~has been~~ learned that while input power was 81W (stabilized at~~in~~ 150℃ at 45V, thus input power W = 45^2 /50x2=81W) when the vacuum thermal insulating box S was inserted, input power was 213W (stabilized at~~in~~ 150℃ at 73V, thus input power W = 73^2 /50x2=213W) when the vacuum thermal insulating box S was not inserted. These results revealed that input power can be reduced to 81/213 owing to the thermal insulating performance of the vacuum

thermal insulating box S.

[0016] Consumption power W, with which the thermal insulating performance of the afore-mentioned vacuum insulating box S is estimated, can be calculated by the operating time and operating voltage of the relay of the temperature controller that supplies~~to supply~~ power to the plane heater H because the ~~supply~~ power supplied to the plane heater H is proportional to the output voltage of the relay of the temperature controller. T~~, and t~~hus, supply power to the plane heater H can be determined by measuring ~~the~~ output voltage and output time of the relay of the temperature controller with an~~the~~ oscillogram, and by obtaining the peak area (the peak integration value) by making use of the integration function of the peak area of the oscillogram. Specifically ~~Namely~~, because the afore-mentioned peak area (a peak integration value) is equal to the output voltage x output time, it is~~can be~~ determined that~~the~~ output time = the peak integration value/the output voltage, and the output % = ~~-6-~~ ~~the~~ output time x 100/ the measuring time = the peak integration value x 100/(the measuring time x the output voltage).

[0017] For example, ~~now~~ assuming that the output voltage of the relay of the temperature controller is 12V and the measuring time 50 seconds, it is~~can be~~ determined that the output % = the peak integration value x 100/(12x50) = the peak integration value/6.

[0018] According to ~~the~~ test results, the peak integration value (the average of 5 points) of the oscillogram at the time when the temperature of the valve unit body V_1 was in a stable state at 150℃, with the vacuum thermal insulating box S

~~being~~ inserted, was 119.0 (V · sec) taking the~~an~~ average. Accordingly, the output % at this time becomes 119/6 = 19.83%. With a~~the~~ rated capacity of the plane heater H of~~is~~ 400W, the output of the plane heater H becomes 400W x 19.83% = 79.3W.

The peak integration value (the average of 5 points) of the oscillogram at the time when the temperature of the valve unit body V_1 was in a stable state at 150℃, with the vacuum thermal insulating box S ~~being~~ removed, was 331.6 (v · sec). Accordingly, the output % at this time becomes 331.6/6 = 55.27%. Thus, the output of the plane heater H becomes 400W x 55.27% = 221.1W.

[0019] When the input power ratio (the case where~~that~~ the vacuum thermal insulating box was in use/the case where~~that~~ the vacuum thermal insulating box was not in use = 81/213) determined by the afore-mentioned voltage adjustment is compared with the output power ratio (79.3/221.1) determined by the peak integration value on the oscillogram, it was~~is~~ learned that there exists almost no difference

~~-7-~~

between them.

Because ~~the~~ thermal insulating performance of a~~the~~ vacuum thermal insulating box S can be measured easier with the former method, wherein~~with which~~ the input voltage to the plane heater H is adjusted, for~~with the~~ embodiments of the present invention, the verification test for the vacuum insulating characteristics is conducted using~~by~~ the method of adjusting the~~said~~ input voltage.

[0020] In the case where~~that~~ the vacuum insulating box S, according to the

combination of 3 vacuum jackets S_1, S_2, S_3 is used as shown in Figure 22 to ~~∼~~Figure 25, ~~the~~ thermal insulating performance expressed by the ratio of input voltage to the plane heater H is 81/213, which is not a sufficient performance ~~is found to be not sufficient~~.

[0021] Another problem encountered is that the thermal insulating performance is lowered because the~~said~~ vacuum thermal insulating box S in Figure 22 to ~~∼~~Figure 25 is structured by combining 3 segments, which leads to high thermal conductivity by ~~the~~ solid heat transfer.

[0022] Furthermore, another problem with the afore-mentioned vacuum thermal insulating box S shown in Figure 22 to ~~∼~~Figure 25 is that, because a 2mm-thick stainless steel plate is employed from the view point of providing~~its~~ mechanical strength, ~~the~~ thermal conductivity by ~~the~~ solid heat transfer becomes relatively high.

[0023] Patent Document: TOKU-KAI-SHO No.61-262295 Public Bulletin

~~Disclosure of the Invention~~

Object of the Invention

[0024] It is a primary object of the present invention to solve the -

~~-8-~~

afore-mentioned problems with a vacuum thermal insulating box S, which basic development was performed by inventors of the present invention, as shown in Figure 22 to ~~∼~~Figure 25, that has~~is,~~ (a) insufficient thermal insulating performance, (b) a substantial decrease in the thermal insulating performance by solid heat transfer due to the reason that 3 segments are combined.

Another primary object of the present invention is~~, and~~ to provide a vacuum thermal insulating valve that~~which~~ is small-sized and equipped with the high thermal insulating performance, and is made by combining a jacket-type vacuum thermal insulating box S with ~~the~~ better thermal insulating performance by using 2 vacuum jacket segments and a valve V.

Summary of the Invention~~Means to Achieve the Object~~

[0025] The present invention in accordance with a first embodiment~~as claimed in Claim 1~~ is fundamentally ~~so~~ constituted so that, with the vacuum thermal insulating valve formed by a valve equipped with a valve body and an actuator, and a vacuum thermal insulating box that~~which~~ houses this~~said~~ valve, the afore-mentioned vacuum thermal insulating box S comprises a square-shaped lower vacuum jacket S_5 equipped with a cylinder-shaped vacuum thermal insulating pipe receiving part on its side, and also with an upper face that~~which~~ is made open, and a square-shaped upper vacuum jacket S_4 hermetically fitted to the~~said~~ lower vacuum jacket S_5 from the above, and also with a lower face that~~which~~ is made open; and the jointed part 2d' is formed by bending the inner wall 8b and the outer wall 8a' of the upper end of the afore-mentioned lower vacuum jacket S_5 toward the inside in the shape of a brim, and also the jointed part 2d is formed by bending the center part of the height -

~~-9-~~

direction of the side of the~~said~~ lower vacuum jacket S_5 toward the outside in the shape of a brim, and further the jointed part 2c is formed by bending the inner wall 7b and the outer wall 7a of the lower end of the afore-mentioned upper

vacuum jacket S_4 toward the outside in the shape of a brim, and ~~the~~ both are combined in a~~the~~ manner that the vacuum thermal insulating side wall of the upper vacuum jacket S_4 is positioned toward the outside of the vacuum thermal insulating side wall of the afore-mentioned lower vacuum jacket S_5, to make the jointed part 2c of the lower end of the afore-mentioned –upper vacuum jacket S_4 and the jointed part 2d of the outer wall side of the lower vacuum jacket S_5 hermetically sealed~~contacted~~ by installing ~~a~~ thermal insulating material layer K, and also to make the jointed part 2d' of the inner wall 7b of the ceiling part of the upper vacuum jacket S_4 and the upper end of the lower vacuum jacket S_5 hermetically sealed~~contacted~~ by installing ~~a~~ thermal insulating material layer K.

[0026] The present invention in accordance with a second embodiment modifies the first embodiment ~~as claimed in Claim 2 according to Claim 1 is so made~~so that the~~a~~ valve V is equipped with a valve unit body V_1 made by a plural number of valve bodies V_{10}, V_{20} ... that are~~being~~ integrally connected.

[0027] The present invention in accordance with a third embodiment modifies the first embodiment ~~as claimed in Claim 3 according to Claim 1 is so made~~ so that a heater H is mounted on the~~a~~ valve body, and the~~said~~ heater H is made to be a plane heater fixed to the valve body.

[0028] The present invention in accordance with a fourth embodiment modifies the first embodiment ~~as claimed in Claim 4 according to Claim 1 is so constituted~~ so that the~~a~~ valve body has an~~to which~~ outer surface to which a plane heater H is fixed and ~~with which~~an inner part equipped with a valve seat and a valve seat part~~are equipped~~.

[0029] The present invention in accordance with a fifth embodiment modifies

the first embodiment ~~as claimed in Claim 5 according to Claim 1 is so~~

~~-10-~~

~~made~~ so that the~~a~~ thermal insulating material layer K is made of a silicon sponge.

[0030] The present invention in accordance with a sixth embodiment modifies the first embodiment ~~as claimed in Claim 6 according to Claim 1 is so made~~ so that the outer wall 7a of the upper vacuum jacket S_4 is 2mm thick and its inner wall 7b is 1.5mm thick, and the inner wall 8b of the lower vacuum jacket S_5 is 2mm thick and the lower part 8a of its outer wall is 2mm thick and the upper part 8a' of the side wall of the outer wall is 1.5mm thick, and each wall is~~they are~~ made of stainless steel so that deformation of the flat plate is prevented at the time of evacuation by~~with~~ such thickness.

[0031] The present invention in accordance with a seventh embodiment modifies the first embodiment ~~as claimed in Claim 7 according to Claim 1 is so constituted~~ so that the~~a~~ vacuum thermal insulating pipe receiving part J installed on the side of the lower vacuum jacket S_5 is made to be a 50mm to ~~∼~~150mm long cylinder-shaped vacuum jacket made of a 2mm-thick stainless steel plate, and O-rings 4a, 4b made of ~~the~~ thermal insulating material are placed on the peripheral face of one end or both ends of a~~the~~ tip part 3a of the vacuum thermal insulating pipe 3 to be inserted into the~~said~~ vacuum thermal insulating pipe receiving part from the outside, and the afore-mentioned O-rings 4a, 4b made of ~~the~~ thermal insulating material are caught between the vacuum thermal insulating pipe receiving part J and the tip part 3a thereof

[0032] The present invention in accordance with an eighth embodiment

modifies the first embodiment ~~as claimed in Claim 8 according to Claim 1 is so constituted~~ so that the jointed parts 2c, 2d in the shape of a brim of the side walls of the upper and lower vacuum jackets S_4, S_5 combined in an opposite direction are pressed by a plural number of press-clips 5 with an appropriate space.

[0033] The present invention in accordance with a ninth embodiment modifies the first embodiment ~~as claimed in Claim 9 according to Claim 1 is so~~

~~-11-~~

~~made~~ so that a~~the~~ height of an~~the~~ overlapped part W, in~~with the~~ combination with~~of~~ the upper and lower vacuum jackets S_4, S_5 that~~which~~ forms the side wall of the vacuum thermal insulating box S, is made to be more than 100mm.

[0034] The present invention in accordance with a tenth embodiment modifies the first embodiment ~~as claimed in Claim 10 according to Claim 1 is so made~~ so that the inner wall face of the vacuum thermal insulating spaces 2a, 2b, 2b' of the upper and lower vacuum jackets S_4, S_5 undergoes~~is performed the~~ heat treatment after plating.

Effects of the Invention

[0035] With the present invention, a vacuum thermal insulating box S is formed by combining ~~the~~ upper and lower vacuum jackets S_4, S_5, and the length of the overlapped part W, with the combination of both jackets, is made to be more than approximately one half of the height (e.g., more than approximately 100mm) of the vacuum thermal insulating box S, and the thickness of the wall material 7b, 7a' on the one part which forms the afore-mentioned overlapped part W of both vacuum jackets S_4, S_5 is made to be thinner than the thickness of

the wall material on the other part, thus considerably enhancing the vacuum thermal insulating performance ~~considerably~~ due to a~~the~~ substantial decrease in ~~the~~ solid heat transfer volume.

[0036] Also, in accordance with the present invention, a silicon sponge made thermal insulating layer K is employed so that hermeticity of the overlapped part, formed by~~with~~ the combination of both vacuum jackets S_4, S_5, is enhanced and ~~the~~ solid heat transfer is reduced. T~~, and t~~hus, a~~the~~ higher thermal insulating performance is -

~~-12-~~

assured due to the fact that there is no heat leakage at all from the inside of the vacuum thermal insulating box S because the box~~it~~ is ~~so~~ constituted such that the jointed parts 2c, 2d, 2d' are formed on ~~the~~ end parts of both vacuum jackets S_4, S_5.

[0037] Furthermore, there is no chance at all that the gas ~~is~~ condenses~~d~~ inside the valve unit body V_1 because the~~due to the reason that said~~ valve unit body employed is heated with the plane heater H, thus providing~~enabling to supply~~ a vacuum thermal insulating valve that is small and compact in size and at ~~the~~ lower cost.

Brief Description of the Drawings

[0038] Figure 1 is a partial cutaway front view of a vacuum thermal insulating valve in accordance with the present invention.

[0039] Figure 2 is a left side view of Figure 1.

[0040] Figure 3 is a right side view of Figure 1.

[0041] ~~———~~Figure 4 is a plan view of Figure 1.

[0042] ~~———~~Figure 5 is a perspective view of a vacuum thermal insulating box that~~which~~ forms a vacuum thermal insulating valve in accordance with the present invention.

[0043] ~~———~~Figure 6 is a partially enlarged perspective view of the part with the combination of a lower vacuum thermal insulating jacket and an upper vacuum thermal insulating jacket.

[0044] ~~———~~Figure 7 is a partially enlarged perspective view showing the jointed part of a joint of the lower vacuum thermal insulating jacket and a vacuum thermal insulating pipe.

~~-13-~~

[0045] Figure 8 shows the positions of measuring points in the thermal insulating performance test of the vacuum thermal insulating valve in accordance with the present invention (a front view).

[0046] ~~———~~Figure 9 shows the positions of measuring points in the thermal insulating performance test of the vacuum thermal insulating valve in accordance with the present invention (a left side view).

[0047] ~~———~~Figure 10 shows the positions of measuring points in the thermal insulating performance test of the vacuum thermal insulating valve in accordance with the present invention (a plan view).

[0048] ~~———~~Figure 11 shows the positions of measuring points in the thermal insulating performance test of the vacuum thermal insulating valve in accordance with the present invention (a left side view).

[0049] ~~———~~Figure 12 is a curve ~~to~~ showing the temperature distribution of

the measuring points when the temperature of the valve unit body V_1 is made to be 150℃.

[0050] ————Figure 13 is a diagram ~~to~~ showing the relationship between the temperature of measuring points and the distance from the jointed parts of the jacket (i.e., an upper jacket).

[0051] ————Figure 14 is a diagram ~~to~~ showing the relationship between the temperature of measuring points and distance from the jointed parts of the jacket (i.e., a lower jacket).

[0052] ————Figure 15 is a cross-sectional view ~~to~~ showing the~~e~~ jointed part of the upper jacket and the lower jacket.

[0053] ————Figure 16 is a partial cross-sectional view to show another example of –

~~-14-~~

the joint.

[0054] ————Figure 17 is a front view of~~to show~~ an example of a unit valve that~~which~~ forms the present invention.

[0055] ————Figure 18 is a block diagram of the flow passage in Figure 17.

[0056] ————Figure 19 is a front view ~~to~~ showing another example of a unit valve that~~which~~ forms the present invention.

[0057] ————Figure 20 is a block diagram of the flow passage in Figure 19.

[0058] ————Figure 21 is a perspective view of~~to show~~ an example of a vacuum thermal insulating box.

[0059] ————Figure 22 is a front view of the vacuum thermal insulating box that~~which~~ is formed of 3 vacuum jackets.

[0060] ——Figure 23 is a left side view of the vacuum thermal insulating box shown in Figure 22.

[0061] ——Figure 24 is a plan view of the vacuum thermal insulating box shown in Figure 22.

[0062] ——Figure 25 is a drawing ~~to~~ showing the measuring points of the vacuum thermal insulating box shown in Figure 22.

[0063] ——Figure 26 is a diagram ~~to~~ showing the relationship between ~~the~~ temperature of the measuring points of the vacuum thermal insulating box and the distance from the inner wall face shown in Figure 22. (No.1 vacuum jacket)

[0064] ——Figure 27 is a diagram ~~to~~ showing the relationship between ~~the~~ temperature of the measuring points of the vacuum thermal insulating box and the distance from –

~~-15-~~

the inner wall face shown in Figure 22. (No.2 vacuum jacket)

List of Reference Characters and Numerals

[0065~~39~~] V Valve

V_1 Valve unit body

V_{10} Valve body

V_{20} Valve body

V_{n0} Valve body

D Actuator

S Vacuum thermal insulating box

S_1 No.1 vacuum jacket

S_2 No.2 vacuum jacket

S_3 No.3 vacuum jacket

S_4 Upper vacuum jacket

S_5 Lower vacuum jacket

W Overlapped part of~~with~~ the combination of the upper and lower vacuum jackets

J Vacuum thermal insulating pipe receiving part

K Silicon sponge made thermal insulating material layer

H Heater

G Getter case

O Shut-off valve

Q Cable takeout opening

~~16~~

OUT,~~-~~IN Temperature measuring points

1 Vacuum thermal insulating valve

2a, 2b, 2b' Vacuum thermal insulating spaces

2c Jointed part of the lower end part of the upper vacuum jacket

2d Jointed part of the outer wall of the lower vacuum jacket

2d' Jointed part of the upper end part of the lower vacuum jacket

2e,~~-~~2f Welded part

3 Vacuum thermal insulating pipe

3a Tip part

3b,~~-~~3c Step parts

4a, - 4b Thermal insulating material made O-ring

5 Press clip

6 Pipe heater

7a Outer wall of the upper vacuum jacket

7b Inner wall of the upper vacuum jacket

8a Outer wall of the lower vacuum jacket

8a' Outer wall above from the center part of the lower vacuum jacket

8b Inner wall of the lower vacuum jacket

9 Metal pipe

10 Pipe fitting

Detailed Description of~~Best Mode of Carrying Out~~ the Invention

[0066~~40~~] The following embodiments in accordance with the present invention

~~-17-~~

are described with reference to the drawings as follows~~hereunder~~.

Figure 1 is a partial cutaway front view of a vacuum thermal insulating valve in accordance with the present invention. Figure 2 is its left side view, Figure 3 is its right side view, and Figure 4 is its plan view. Figure 5 is a perspective view of a vacuum thermal insulating box S in accordance with~~which constitutes~~ the present invention.

[0067~~41~~] Referring to Figure 1 to Figure 5, a vacuum thermal insulating valve 1, in accordance with the present invention, comprises a valve V and a vacuum thermal insulating box S that~~which~~ surrounds the valve V.

The afore-mentioned valve V comprises a valve unit body V_1 and a

plural number of actuators D and heaters. Furthermore, the vacuum thermal insulating box S comprises an upper vacuum jacket S_4 and a lower vacuum jacket S_5.

Embodiment 1

[0068~~42~~] As shown in Figure 15 and Figure 17, the afore-mentioned valve V comprises a valve unit body V_1 that is formed by connecting, removably and integrally, ~~with~~ a plurality ~~number~~ of valve bodies V_{10}, V_{20}, V_{30}, and actuators D, D...and the like fixed to the valve bodies V_{10}, V_{20}, V_{n0}. A metal made diaphragm-type valve, which is ~~has been~~ already known, has been often employed for the fore-mentioned valve bodies V_{10}, V_{20}. Furthermore, a pneumatically operated cylinder, or an electrically operated driving mechanism, have been ~~well~~ employed for actuators D, C...., -

~~-18-~~

Detailed explanation on the~~said~~ valve V is thus omitted herewith ~~because~~ its structure is ~~has been~~ well known. Valve seats and valve seat parts of the valve bodies V_{10}, V_{20}, which are used with the present invention, are positioned on inner sides of the valve bodies V_{10}, V_{20} so that they can be easily heated by the heater H.

[0069~~43~~] A vacuum thermal insulating box S is formed by combining and fixing an upper vacuum jacket S_4 and a lower vacuum jacket S_5. Specifically~~Namely~~, as shown in Figure 6, the upper vacuum jacket S_4 and the lower vacuum jacket S_5 are formed by combining a 1.5mm thick stainless steel plate 7b, 8a' and a 2.0mm thick stainless steel plate 8a, 8b in the shape of a dual wall. The

vacuum thermal insulating space 2a (with an~~the~~ approximately 4.5mm clearance) of the upper vacuum jacket S_4 is held at a degree of vacuum of approximately 10^{-2} to~~∼~~ 10^{-4} -torr. A degree of vacuum less than 10^{-4} -torr under high temperature is held by a getter.

[0070~~44~~] The clearance of the vacuum layer 2b of the lower part of the lower vacuum jacket S_5 is made to be 13mm. The part W to which the upper vacuum jacket S_4 fits (i.e., the combined and overlapped part W of the upper and lower vacuum jackets S_4, S_5) has with the vacuum layer 2b' ~~with~~ a space distance of approximately 4.5mm.

The height (that is, the heat transfer distance) of the fitted part (i.e., the combined and overlapped part W) of both vacuum jackets S_4, S_5, which constitutes the part affected by the heat transfer, is made to be approximately 100mm.

[0071~~45~~] More specifically~~concretely~~, the outer wall 7a of the upper vacuum jacket S_4 is made to be 2mm thick and the inner wall 7b is 1.5mm thick, for which a stainless-

~~-10-~~

steel plate is used.

On the other hand, the lower part (including the bottom face) of the outer wall 7b of the lower vacuum jacket S_5 is made to be 2mm thick and the inner wall 8b is 2mm thick, and the upper side wall (the overlapped part W) 8a' of the outer wall 8b is 1.5mm thick, for which a stainless steel plate is used.

[0072~~46~~] A getter case G and a shut-off valve O are mounted on the afore-mentioned upper vacuum jacket S_4 and lower vacuum jacket S_5,

respectively. Furthermore, the former is equipped with a takeout opening Q for a cable and a valve driving air pipe, while the latter is equipped with a vacuum thermal insulating pipe receiving part (i.e., a joint) J for connecting a vacuum thermal insulating pipe (not illustrated).

[0073~~47~~] The inner wall 7b and outer wall 7b, which form the lower end part of the afore-mentioned upper vacuum jacket S_4, are bent toward the outer side in the shape of a brim, and the jointed part 2c is formed in the shape of a brim by both being jointed.

Similarly, the inner and outer walls 8b, 8a', which form the upper end part of the lower vacuum jacket S_5, are bent toward the inner side~~,~~ and the jointed part 2d' is formed in the shape of a brim.

Furthermore, on the center part of the side wall of the lower vacuum jacket S_5, there is formed a jointed part 2d that~~which~~ is extruded toward the outside by bending the lower end part of the outer wall 8a' and the upper end part of the outer wall 8a toward the outside, respectively, and overlapping them.

[0074~~48~~] The afore-mentioned end faces of the brim-shaped jointed parts 2c, 2d,

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2d' extruded toward the outside are welded to make the welded parts 2e, 2f, thus ~~being~~ hermetically fixed.

Furthermore, as shown in Figure 6, a silicon sponge-made thermal insulating material layer K is provided in~~for~~ the clearances made between the inner wall 7b of the vacuum jacket S_4 and the jointed part 2d', and also between the jointed parts 2d, 2c of~~when~~ both vacuum jackets S_4, S_5. T~~, t~~hus, the

hermeticity between both vacuum jackets S_4, S_5 is~~being~~ secured and ~~the~~ solid heat transfer is~~being~~ prevented.

[0075~~49~~] A 1.2mm thick stainless steel plate is used for the vacuum thermal insulating pipe receiving part J, mounted on the side of the afore-mentioned lower vacuum jacket S_5, to form a so-called Bionett joint type vacuum thermal insulating part as constituted in Figure 7.

Specifically~~Namely~~, it is ~~so~~ constituted so that the receiving part J and the vacuum thermal insulating pipe 3 are hermitically connected in a~~the~~ manner so that ~~the~~ part 3a, having~~with~~ a smaller diameter as~~of~~ the tip of the vacuum thermal insulating pipe 3, is inserted therein, and the tip face of the receiving part J and the step part 3b of the part 3a, which has~~with~~ a small diameter as~~of~~ the tip of the vacuum thermal insulating pipe 3, are contacted through the mediation of a~~the~~ thermal insulating-material made ring 4a. The length of the receiving part J is made to be approximately 100mm.

[0076~~50~~] In~~With~~ Figure 7, 6 designates a heater, 9 a metal pipe, and 10 a pipe joint.

Detailed explanation on the structure of the~~said~~ vacuum thermal insulating pipe receiving part J, pipe joint 10, and the like, is omitted herewith because they are well known.

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[0077~~51~~] Next, the thermal insulating characteristics test performed on the thermal insulating valve 1, in accordance with the present invention, and the test~~its~~ results are described.

First, as shown in Figure 8 to Figure 11, a 5-gang type valve (a unit

valve) V is housed in a vacuum thermal insulating box S of the breadth of approximately 400mm, the height of approximately 190mm, the depth of approximately 180mm, and the length of the receiving part J is approximately 100mm and the height of the overlapped part W of the upper and lower vacuum jackets S_4, S_5 is approximately 100mm, and a plane heater H of 400W (200W x 2) is fixed to the valve unit body V_1. T~~, and t~~emperature measuring sensors (manufactured by OKAZAKI SEISAKUSHO CO., LTD.) are installed at the positions IN and OUT as shown in Figure 8 to Figure 11.

[0078~~52~~] Next, the voltage determined by the actual measurement beforehand, which raises the temperature of the valve unit body V_1 approximately to 150℃, was applied to the plane heater H~~,~~ to find the relationship between the time of ~~the~~ temperature sensor~~s~~ reading and the detected temperature.

[0079~~53~~] The results are as shown in Figure 12. It has been learned that with a room temperature of approximately 26.3℃, the temperature (OUT-6 points) of the upper face side of the upper vacuum jacket S_4 may~~could~~ rise only to 34.3℃, and the temperature (OUT-8 points) of the side of the lower vacuum jacket S_5 may~~could~~ rise only to 44.7℃.

[0080~~54~~] Next, the temperature of the valve unit body V_1 was stabilized to 150℃, and then, under this stabilized condition, the temperature of temperature measuring points (OUT) of the outside of the upper vacuum jacket S_4 and the lower vacuum jacket ~~ket~~

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S_5 was measured.

The results are shown in Figure 13 and Figure 14, which show the

relationship between the afore-mentioned measurement values and the distances from the overlapped part (the jointed part) W of both vacuum jackets S_4, S_5.

[0081~~55~~] In the case where the~~said~~ 2-way split type vacuum thermal insulating box S shown in Figure 1 to Figure 4 is employed, the input power required to keep the valve unit body V_1 heated to 150℃ was determined by the input voltage adjusting method. Two plane heaters of 200W (100V · 50Ω) x 2 for the valve unit body V_1 were employed. According to the test results, the valve unit body V_1 was held at 150℃ with the input voltage of 37V. Accordingly, in this case, the input was $(37^2/50) \times 2 = 54.8$W~~.~~ (the input was 213W when a vacuum thermal insulating box was not employed). It is found that the vacuum thermal insulating performance is remarkably enhanced compared~~ing~~ to~~with~~ the input power of 81W in the case of the afore-mentioned 3-way split type vacuum thermal insulating box S shown in Figure 22 to Figure 25.

Embodiment 2

[0082~~56~~] Figure 15 shows another embodiment in accordance with the present invention. This second~~With said~~ embodiment~~ 2, it~~ is ~~so~~ constituted so that the upper and lower vacuum thermal insulating jackets S_4, S_5 are combined and fitted, and then their jointed parts 2c, 2d, in the shape of a brim, are pressed by the cross sectional u-shaped clip 5 through the mediation of the thermal insulating material layer K. Hermeticity of both jackets is enhanced by pressing brim-shaped jointed parts –

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2c, 2d with an appropriate distance, using the~~said~~ clip 5 to press;~~,~~ thus, consumption power to hold the afore-mentioned valve unit body V_1 to 150℃ is~~being~~ reduced from 54.8W to 43.0W. This enhancement has been verified through the experiment.

Embodiment 3

[0083~~57~~] Figure 16 further shows ~~further~~ another embodiment in accordance with the present invention. This third embodiment~~It~~ is ~~so~~ constituted so that the tip part of ~~the~~ part 3a, provided with a smaller diameter of the vacuum thermal insulating pipe 3 for insertion ~~to be inserted~~ into the receiving part J, is equipped with a step part 3c, to which a silicon rubber ~~-~~made O-ring 4b is fitted. ~~,~~ ~~————~~By achieving this construction~~said constitution~~, hermeticity between the tip part 3a of the vacuum thermal insulating pipe 3 and the inner wall face of the joint J is enhanced. Heat leakage inside the vacuum thermal insulating box S, toward the outside, is shut out at the heat source side, thus resulting in further improvements in ~~the~~ thermal insulating performance.

[0084~~58~~] The reason why a silicon rubber made sponge is employed as~~for~~ the afore-mentioned thermal insulating material layer K, or that a silicon rubber made thermal insulating material is used for the thermal insulating O-rings 4a, 4b, in accordance with the present invention is because they have both high heat resistance and excellent hermeticity. For~~With~~ this~~e~~ embodiment, the product made with the low polymer resin, Siloxane by SHINETSU POLYMER CO., LTD., is~~Is~~ employed.

Feasibility of Industrial Use

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[0085~~59~~] A vacuum thermal insulating valve, in accordance with the present invention, is mainly utilized with ~~the~~ pipes in ~~the~~ gas supply systems or vacuum exhaust systems with semiconductor manufacturing facilities or plasma generating apparatuses. However, the present invention~~it~~ is not limited to the afore-mentioned semiconductor manufacturing facilities and the like, but also may be utilized as ~~the~~ constituent components for ~~the~~ gas supply systems or ~~the~~ gas exhaust systems used in chemical, pharmaceutical or food-processing industries and the like.